PUBLIC WORKS DEPARTMENT.

Recd. } 1907.
Regd.

Enclosures

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Circular Memorandum, No. 1323, 4th April 1907.

Project estimates

Instructions for the preparation of — for submission to the Government of India.

PUBLIC WORKS DEPARTMENT

No. 1323, dated 4th April 1907.

CIRCULAR MEMORANDUM.

A great many of the project estimates which have been sent up to the Government of India for sanction have been returned by the Inspector-General of Irrigation for various reasons, the chief of which has been want of sufficient detail. The Chief Engineer for Irrigation during the Inspector-General's recent visit to Madras discussed the question with him with a view to ascertaining what steps are necessary to satisfy his requirements, with the result that the Inspector-General stated that he desires estimate to be submitted in accordance with the rules laid down in the Public Works Code.

2. Accordingly the attention of all Superintending Engineers and Executive Engineers is invited to Code paragraphs 862 to 891 inclusive, in which very full and comprehensive instructions are laid down for the submission of Irrigation projects.

3. There is no doubt that a good many projects have been submitted in a shape which cannot be said to conform in all respects to the above rules, more especially with regard to the amount of detailed information given on the plans. This was, it is believed, largely due to a misapprehension as to the amount of details required, and the object of the present circular is to lay down general rules for the future which if carried out will enable sanctions to estimates to be more readily obtained than has hitherto been the case.

4. In the first place it is hardly necessary to state that the main objects in view are—

(1) To design a project which is thoroughly sound in principle and which may reasonably be expected to do what is required of it.

(2) To obtain a reliable estimate of cost.

5. The amount of investigation required will of course vary in different cases but must be sufficient to obtain the above results and it is desirable that as many as possible of the results of the investigation, especially in the shape of levels, surveys and trial pits, etc., should be recorded on the plans in such a shape as to enable the officers to whom the estimates are submitted for approval, *i.e.*, the Inspector-General or the Chief Engineer for Irrigation, as the case may be, to see clearly from the plans why certain alignments are adopted or proposals made and form their own conclusion from the information given on the plans.

6. In many cases a great deal of work has been done in the shape of trial lines, cross sections, etc., which has not been recorded on the plans and the checking officer has therefore either to take for granted that the necessary investigation has been done or return the estimates for revision, neither of which courses is satisfactory to any one concerned. The amount of investigation to be carried out must generally be left to the discretion of the officer in direct charge as it will entirely depend on the nature of the country concerned and the difficulties met with, but whatever is done should be-

carefully recorded either on the plans submitted for sanction or in such a form as to be readily available for subsequent reference. It may be remarked here that in several cases the office copies and records of investigation of large projects have at the close of the investigation been simply "dumped" in a state of confusion into the nearest Public Works Department office, with the natural result that when further information has been required it has not been available and much of the work done has been practically wasted. It is particularly requested therefore that steps may invariably be taken in future to have all the records of project investigation carefully arranged and recorded and clear office copies of plans kept.

7. In addition to the recording of levels, etc., on the maps and trial pits on the longitudinal sections more attention is required to the reports which accompany the estimate which should be full and clear and systematically arranged and in this connection it may be reported here that except for very small and unimportant estimate no report should be written by any one below the rank of Executive Engineer. It has also been noticed that officers writing reports are far too apt to forget that their descriptions must be intelligible to those who have not seen the places referred to and who have to depend entirely on what is put before them in the shape of descriptive reports and plans.

8. Another important point in connection with projects is the necessity for leaving more permanent marks on the ground from which to find the alignment some time after the completion of investigation. Pegs are of course useless for this purpose and, when the expense of B.M. stones fixed in concrete is not considered justifiable, cheaper marks such as stone cairns or maunds of earth can be adopted.

When rocks are available on the lines marks can be cut on them.

The nature of the marks adopted is left to the discretion of the local officers but the necessity for them is so obvious that it is brought to notice here to guard against omission in future.

9. As regards trial pits the number required must depend upon the contour of the country and the nature of soils, but except country which is very uniform in both respects the pits for all important channels should be not more than a furlong apart.

Here again the object to be attained is a reliable estimate of cost and the local officers must see that they attain this object.

The results of the trial pits for a channel should be clearly recorded on the longitudinal section.

10. The same principles as given above are to be followed in deciding to what extent detailed plans and estimates are required but the following general rules may be followed.

All main channels and branch channels exceeding 20 miles in length to be estimated in detail.

For the remaining branch channels and distributaries a sufficient number to be estimated in detail to obtain an average rate either per mile of distributary or per acre of ayakat, which rate may then be applied to the remainder.

In either case it will be necessary to divide the distributaries into classes and to see that a sufficient number of typical instances of each class is estimated for.

The following four classifications were made for the Tungabhadra Project and may be provisionally adopted :—

Class (1) Channels above 400 cusecs of discharge.
,, (2) ,, from 200 to 400 cusecs of discharge.
,, (3) ,, from 100 to 200 cusecs of discharge.
,, (4) ,, below 100 cusecs of discharge.

11. As regards masonry works all individual works requiring a special plan must be designed and estimated in detail. For other works a sufficient number of type plans must be drawn and estimated in detail to enable a reliable estimate of cost of the remainder to be framed and generally not less than one-third of the works required should be designed in detail.

12. As regards details of design the following points should receive attention :—

(*a*) *Design of channels.*—For all channels above 50 feet bed-width Kutter's co-efficient to be taken at 0·020 and for all below 50 feet 0·0225.

The following proportion of depth to bed-width to be generally adopted :—

Bed-width.	Depth to bed-width.
20 to 50 feet	1 to 7
50 to 250	1 to 10

The following allowances for percolation to be made per million square feet of wetted perimeters of the full supply section :—

	Cusecs.
(1) In cross section in which outcrops of gravel or decayed rock occurs ..	10
(2) Alluvial or red soil	8
(3) Black cotton soil	5
(4) Rock cutting to F.S.L.	3
(5) Tunnels	2

Maximum capacity of channel for irrigation to be 1·30 times the average capacity. Channels to be generally aligned as far as practicable so as to make depth of cutting 1·25 times the depth at which embankment and cutting balances so as to give an economical section and the masonry works designed to suit it.

High banks to be avoided wherever practicable to do so.

For large and important canals, say over 100 feet bed-width, one bank should be not less than 23 feet crest-width so as to carry a driving road and wherever practicable the best soil available should be used to form a good surface.

The second bank should be not less than 15 feet crest-width.

Smaller canals, say between 50 feet and 100 feet bed-width, should have one bank not less than 15 feet and the other 9 feet.

No canal except minor distributaries less than 10 feet bed-width should have banks with less crest-widths than 6 feet.

The margin above M.W.L. need not generally exceed 3 feet and may be reduced to 2 feet wherever safe to do so.

All banks should have a hydraulic gradient of 1 in 4 except where short depressions are crossed where 1 in 6 gradient should be allowed by means of a berm in rear.

When the slopes of banks are flatter than those of cutting in the ratio of $\frac{1}{2}$ to 1, the space for berms on the inside should be allowed for with a width = constant $+ \frac{\text{depth of digging}}{2}$ which will keep the edge of bank a straight line. The general formula from which this is deduced is as follows :—

Width of berm $= C + (S_2 - S_1)\,x$ where

C is a constant,

S_2 and S_1 are the side slopes of bank and cutting respectively,

and x is the depth of cutting.

Where the canal crosses depressions the banks to be set back not less than 8 feet so as to allow room for silt berms to form. As a rule berms should not be made up artificially but left to form themselves with silt. Spoil banks and borrow pits to be invariably marked on cross sections.

(*b*) *Drops and falls.*—The crest-width should be bed-width of canal and the velocity of approach be controlled by trapezoidal notches.

Depth of cistern below bed level to be $\frac{\text{depth of full supply} + \text{drop in bed}}{3}$

Length of cistern to bottom of reverse slope to be $\frac{1}{3}\sqrt{hd} + 2h$

where h = depth of full supply on crest.

d = drop in bed.

The floor of cistern to be of ashlar and to have a reverse slope of 1 in 3. The latter may be built of roughstone pitching and the bed and side of canal to be protected by pitching for not less than 100 feet below.

When the sub-soil is sufficiently hard the water cushion may be dispensed with altogether.

(*c*) *Syphons.*—The thickness of arch at crown should generally be not less than one-third hydrostatic head of pressure (*vide* page 16 of volume II of Irrigation Conference of 1904).

(*d*) *Sluices and regulators.*—Wherever built on sand or light soil which is not impervious to water a gradient of 1 in 4 should be drawn and the work designed as regards width and depth of foundation and floor to be safe against blowing up.

This result may usually be attained by providing a sufficient thickness of water-tight puddle on bed and sides of upstream channel protected by dry rubble.

13. Stability diagrams should accompany all designs for piers to show that they are safe against overturning and should be as usual submitted for all parts of masonry designs which require them.

14. The above instructions must be rigidly followed for all estimates which require the sanction of the Government of India unless there are very special reasons which will justify any departure from them, in which case very full explanation will be required.

15. As regards estimates which are within the powers of sanction of the Local Government, while the general principles laid down above must be adhered to, modifications in the details of design may be made when considered desirable on grounds of expense or when justified by past experience. Full reasons should, however, be invariably given.

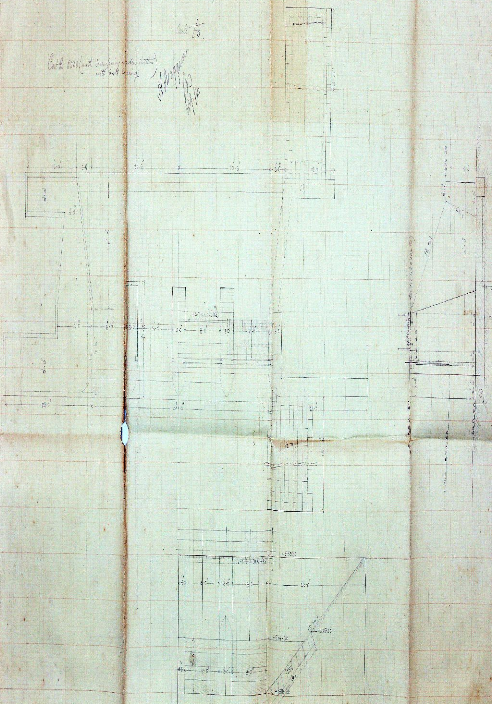
C. A. Smith,
Chief Engineer for Irrigation.

To all Superintending Engineers.

Constructing a Separate new Regulator
instead of "Adding Regulating arrangements with Iron Shutters"
to Bridge at 23R-7f of Sirsa main canal

Scale $\frac{1}{50}$

Cost Rs 6500 (with Screw gearing wooden shutters with ball bearings)



Rough Cost

ESTIMATE FORM.—Abstract.

Quantity.	Description of Work.	Rate.	Per.	Amount	Total.
1	2	3	4	5	6
	Constg a new Regulator instead of "Improvements to Bridge at 28M-7F of Periyar main channel	Rs.		Rs.	Rs.
67.00	Coursed Rubble in mortar 1st sort	19/-	cft 100	1273	
83 cft	Cutstone work	1-0-0	cft	83	
2420	Cutstone in mortar	1-0-0	cft	2420	
25 Sqrs	Pointing with mortar			75	
0.5 Tons	R.S. Beams	200/	Ton	100	
44 cft	Teak wood platform	4/-	cft	176	
90 Rft	Hand railing	1-4-	Rft	113	
No: 4	Teak wood shutters with ball bearings	500/	Each	2000	
1428 cft	Rough stone dry packing (Revetment)	4-0-0	cft 100	57	
700 cft	Gravel backing	Say		30	
	Iron gates at ends of platform			36	
	Tarring			5	
	Painting			30	
	Excavating foundations & filling			300	
	Baling &c			200	
	Railway freight & cartage to Work spot			400	
	Fitting at site			200	
	Unforseen charges			200	
				7692	
	Contingencies 5%			405	
	Petty Supervision 2½%			203	
					8300

Grand Total of Estimate Rs 8300

STATION

Date 190

Executive Engineer.

E. No. 32.

100,000—6-9-07.

CIRCLE— VI

DIVISION— Madura

DISTRICT—

TALUK (OR ESTATE IN CASE OF ESTATE WORKS).

ESTIMATE FORM.—Abstract.

Financial Head—

Budget Head—

Departmental Head—

Main Head—

Sub-Head—

Not approved
Intd CAS
28/1/10

Project of which the work forms part—

Section—

Name of Work— Constructing a new Regulator at about 28M-7f of Periyar main channel

Amount of Estimate, Rs. 8,306

To be carried out by—

REFERENCES.

ESTIMATE FORM.—Detail Measurements.

Detail of Work.	Number.	Measurements in Feet. Length.	Breadth.	Depth.	Area or Contents.	Total Quantity of each description of work.
1	2	3	4	5	6	7
Constructing a Separate Regulator across Periyar main Channel						
Coursed Rubble in mortar I sort						
Foundations						
Under piers and cutwaters	3	4.0	12.5	2.0	300	
" " abutments	2	9.50	9.0	2.0	342	
" Front wings	2	15.0	6.75	2.0	405	
Rear wings	2	9.50	7.0	2.0	266	
Rear returns	2	13.5	4.75	2.0	257	
Retaining wall front	1	44.0	2.0	2.0	176	
Retg. wall rear	1	48.0	2.0	2.0	192	
Flooring between piers	4	10.5	7.0	1.5	441	
Rear floor	1	42.5	9.5	1.50	605	
Superstructure						
Piers	3	7.75	3.0	15.0	1050	
Cutwaters	3	5.8 area		6.0	105	
Caps	3	11 (c) ft			33	
Abutments average	2	8.0	5.50	15.0	1320	
Front wings say	2	18.0	3.9	15.0	2106	
Rear wings say	2	11.25	4.0	11.0	990	
Rear returns	2	12.75	2.9	7.0	534	
Total					9122	
Deduct.						
Cut stone in mortar facing						
abutments	2	33'0"	1⅛	15.0	1114	
Faces of piers + back	3	10.75	1⅛	15.0	544	
					1658	

E. No. 28.
80,000—7-9-06.

ESTIMATE FORM.—Detail Measurements.

Not approved
Intld C.A.J
28/1/10

Detail of Work.	Number.	Length.	Breadth.	Depth.	Area or Contents.	Total Quantity of each description of work.
1	2	3	4	5	6	7
B7					1658	
Sides Face of cut wall	3	6.0	1 1/8	6.0	121	
Faces of piers above cutsed.	3	3.0	1 1/8	8.0	81	
Rear wing	2	15.0	1 1/8	11-0	371	
Rear return	2	12-0	1 1/8"	7.0	190	
Total cut stone facing –					2421	
Total Rubble work less deductions					6700	6700 Cft
Cut stone work						
Sill stone	3	10-0"	2-6	1-0"	75	
Bed stones for girder in platform —	10	1'	1'	9"	8	
Total					83	83 cft
Cut stone in mortar as per above –					2420	2420 cft
Pointing with mortar			L.S.		25 sq.	25 Sq.
R.S. Beam 6"×3"	2	44	12 lb		1056	or say ·5 Ton
Teak wood for platform	1	44	4-9	2½"	44	44 cft
Hand Railing	2	45-0				90 Rft
Teakwood shutters						No: 4
Rough stone revetment front	2	15-0	13-6	1.5	612	
Rear –	2	20.	13-6	1.5	816	
Total					1428	1428 cft
Gravel backing			1/2 of above			700

ESTIMATE FORM.—Detail Measurements.

Detail of Work.	Number.	Length.	Breadth.	Depth.	Area or Contents.	Total Quantity of each description of work.
1	2	3	4	5	6	7
Approximate Cost of Adding Regulating arrangements to Bridge at 28 M-7 f of the Periyar Main channel.						
Coursed Rubble in mortar I sort. Foundations						
Pier & Cutwater extension say	1	4.0	4.0	2.0	32	
Piers & Cutwaters intermediate	2	12.50	3.50	2.0	175	
At abutments	2	4.0	4.0	2.0	64	
Wings	2	5.0	3.50	2.0	70	
Floor or retaining walls	4	6.75	3.0	1.0	81	
Total						
Superstructure						
abutments	2	5.0	3'-0"	14.50	435	
wings	2	8.0	2.0	12.0	384	
Steps	2	5.0	2.5	2.0	50	
Intermediate piers	2	6.25	2.5	10.0	312	
Do projection for platform	2	2.50	2.50	14.5	181	
Cutwaters	2	5.0 area		7.0	70	
					1854	or say 19 hunt
					[illegible]	
Deduct						
grooves	6	0.5	0.5	14.5	22	
Cut stone facing of abut.	2	9-0	1 1/8	14.5	294	
Do— piers say	4	8-0	0.75	10.0	240	
Cutwater protection	2	2.5	0.75	14.5	55	
Cutwaters	2	3.0	0.75	7.0	31	
Total deductions					642	
Total C. R in mortar less deductions					1212	12.00 hunts

E. No. 20
80,000—7-9-05.

ESTIMATE FORM.—Detail Measurements.

Detail of Work.	Number.	Length. (Measurements in Feet.)	Breadth.	Depth.	Area or Contents.	Total Quantity of each description of work.
1	2	3	4	5	6	7
Cut stone in cement						
Piers	1	4½	2½	14-6	162	
Cutwaters	1	5.80		14-6	84	
Total					246	
Deduct groove	2	6"	6"	14-6	7	
Total cut stone in cement					239	240 cft
Cut stone work						
Flooring & sill	4	8.75	3.0	1.0	105	
Total cut stone						105 cft
Cut stone in mortar	as per deduction					640 cft
Rd Beams for platform	8	9-5"	(6"x3")	16#	1248	0.55 Tons.
Planking for platform	1	42.0	3-0"	2"	21	21 cft

ESTIMATE FORM.—Abstract.

Quantity.	Description of Work.	Rate.	Per.	Amount	Total.
1	2	3	4	5	6
	Rough Cost of Adding Regulating arrangement to Bridge at 28 m. 7 f of the Periyar main canal	Rs.		Rs.	Rs.
12.00	Coursed Rubble in mortar I sort	19.00		228	
640 cft	Cutstone in mortar	1.00		640	
240 cft	Do in cement	1.4.0		300	
105 cft	cut stone work	1.0.0		105	
	Dismantling			5	
0.55 Ton	R.S Beams for	200/-	Ton	110	
4 Shutters	Screw gearing shutters 7'-9" x 6' (clear) with ball bearings & complete	500	Each	2000	
21 cft	Teak wood wrought and put up	4.00		84	
	Pointing with cement		LS	70	
	Painting shutters &c		LS	50	
	Excavating foundations & filling			100	
	Baling & unforeseen charges			100	
	Railway freight & cartage to work spot			400	
	Fitting at site			200	
	Railing			120	
	Iron gate at the ends of platform			40	
				4552	
	Contingencies			300	
	Petty Supervision			148	
				5000	
	Grand Total of Estimate				5000

Note I The plan of this Est (a Rough Sketch on tracing paper) has been sent to S.E. II on 29/1/10 with a memo for the S.E.'s reconsideration

STATION

Date 190

Executive Engineer.

E. No. 32.

100,000—6-9-07.

CIRCLE— VI

DIVISION— Madras

DISTRICT—

TALUK (OR ESTATE IN CASE OF ESTATE WORKS).

ESTIMATE FORM.—Abstract.

Financial Head—

Budget Head—

Departmental Head—

Main Head—

Sub-Head—

Project of which the work forms part—

Section—

Name of Work— Adding Regulating arrangements to Bridge at 28M-7f of Periyar main chl.

Amount of Estimate, Rs. 5,000

To be carried out by—

REFERENCES.

T thro H.C

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31.1.10.

T

[illegible]
31.1.10

H.C

This file may be passed on to R.K. as such files are not recorded in T. Section.

[illegible]
31.1.10

... calculated
... head of 3" w/front.
... $h = .5$
... $2 \times 18 \times 6 = 216$ sft.
$D = CA\sqrt{2gh} = .8 \times 8 \times 216 \times .5 = 691$ cusecs.
By inserting an intermediate pier 2½ ft thick
in each bay of the present bridge
the area of the vent will be $4 \times 7\frac{3}{4} \times 6 = 186$
Afflux to discharge 691 cusecs with the
reduced waterway of 186 sft

$$.8 \times 8 \times 186 \times \sqrt{h} = 691 \text{ cusecs.}$$

$$\therefore \sqrt{h} = \frac{691}{.8 \times 8 \times 186} = \frac{691}{1190} = .58$$

$$\therefore h = .58^2 = .58 \times .58 = .33 \text{ ft.}$$

If the discharge of 572 cusecs (carrying capacity of the Chal below the bridge) as originally designed is taken into consideration

then $\sqrt{h}$ will be $\frac{572}{1190} = .48$

$\therefore h = .48 \times .48 = .23$ ft.

[initials]
21/1/00.